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MATHEMATICS IN URBAN SCIENCE:
1. Political Science and Economics

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MATHEMATICS IN URBAN SCIENCE:

I. POLITICAL SCIENCE AND ECONOMICS

Compiled by: Anthony G. White

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Most of the problems in both the physical and social sciences involve either predictive or explanative processes. Two of the most frequently asked, and most basic, questions are: Why did that happen? and What would happen if I do this?

These questions lead the researcher to take an orderly look at the available data and generate testable hypotheses. These hypotheses, concerning some problem or process, are then tested in carefully limited environments, and the results are compared with the hypotheses' predictions to check for congruence. This is the framework of science, a relatively hit-and-miss procedure which usually turns up a lot of experimental failures.

If urban science is ever to generate a coherent body of data within its interdisciplinary boundaries, one of two things is going to have to happen. First, the people in urban areas are going to overcome the natural human reluctance about being part of an experiment - a highly unlikely outcome; or second, the urban scientist is going to have to become a mathematician.

Given the premise that urban science - the interwoven skein of sociology, political science, physical science, economics, and so forth as relates specifically to urban areas - will someday be recognized as an organized body of data, theory, and practice, then the practicioner of the same is going to have to learn mathematics. For if people and institutions are unwilling to participate directly in knowledge-gathering processes, then they will have to be represented mathematically in models, simulations of the actions of real life.

This bibliography is the first in a series of four dealing with mathematics in some of the disciplines of urban science. The four areas of concern, and their sub-

categories, are as follows:

I. Political Science and Economics

Empiricism	Regional economics
Behaviorism	Microeconomics
Government structures	Public finance
Public administration	

II. Sociology

Locational analysis	Criminology
Urbanization processes	Migration
Demography	Social psychology
Small groups	Occupational sociology
Aging	

III. Physical and Biological Sciences

Geography	Network theory
Cartography	Ecology
Meteorology	Public health
Hydrology	Mental health
Physics	Adaptive processes
Chemistry	

IV. Technology and Planning

Computers	Regional planning
Simulation	Land use planning
Games and game theory	Policy analysis

In addition to each bibliographical source, a numerical indicator following each entry gives the general level of mathematics used, according to the following key:

0 - Deductive and Inductive Logic; Set Theory; Numbers; Simple Graphs and Charts; Tables; Percentages

1 - Algebra; Geometry; Trigonometry; Functions; Equations; Systems

2 - Probability; Combinations; Permutations; Statistics; Index Construction

3 - Vectors; Matrices; Linear Algebra

4 - Networks; Information Theory; Communications Theory; Graph Theory

5 - Computers and Programming; Simulation; Game Theory

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6 - Integral and Differential Calculus

7 - Ordinary and Partial Differential Equations

8 - Comples Analysis; Calculus of Variations; Difference Equations and Calculus

9 - Higher order mathematics (e.g., abstract algebra, topology, differential geometry, etc.)

Each succeedingly higher-numbered entry presupposes a knowledge of the material in the lower-numbered entries.

Of necessity, each of these bibliographies will be relatively short. Only in the last twenty years have mathematics played an important role in social science thinking, relative to urban studies. Sources that depend solely upon standard statistical analyses have been avoided, in large part because of the misuse of statistical techniques both in and out of social science studies. Focal in these collections are works in which mathematics play a developmental role, starting with basics and working through advanced concepts, which yield testable, quantifiable systems of analysis for predictive and explanatory purposes.

Conspicuously absent from these listings are the more general mathematical works - national and macro-economics, national and world demography, and so on. These are avoided for the reason that the same potential relationship might exist between the urban level and higher levels as exists between Newton's "Laws of Motion" and Einstein's Theory of Relativity - what may hold as workable on the local level may not apply generally, and vice versa.

As a preliminary matter, a series of mathematical texts is first listed which should give the reader sufficient review of the necessary mathematics up to the level of difficulty desired. (Note: The author received his B.S. in Mathematics from Oregon State in 1967, and was a teaching assistant in the Mathematics Department of the University of Delaware in 1968.)

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II. Sociology

Anthony G. White
City-County Charter Commission
Portland, Ore.

1973
UNIVERSITY OF ILLINOIS
AT URBANA-CHAMPAIGN

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MATHEMATICS IN URBAN SCIENCE:

II. SOCIOLOGY

Compiled by: Anthony G. White

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Useage of mathematics in sociology and in the interpretation of social forces has appeared to most to be Orwellian in implication, based on the assumption that what can be fully described can also be fully controlled.

However, in the sense that the actions of any individual can be controlled or even predicted through mathematical analysis, the fears of 1984 are unfounded. While mathematicians involved in sociological work strive to emulate physicists in mathematical-predictive abilities, even the physicist cannot say where any one individual atom of gas will be at any given time, although he can (with reasonable certainty) predict the number of gaseous particles within a given volume of space.

Since mathematicians, particularly those involved in theoretical work, have a general distain of social science research, the future which seems to hold predictive characteristics for sociology - and urban science - will have to take sociologists and urban scientists and mold them into mathematicians.

Given the premise that urban science - the interwoven skein of sociology, political science, physical science, economics, and so forth as relates specifically to urban areas - will someday be recognized as an organized body of data, theory and practice, then the practicioner of the same is going to have to learn mathematics. For if people and institutions are unwilling to participate directly in knowledge-gathering processes, then they will have to be represented mathematically in models, simulations of the actions of real life.

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MATHEMATICS IN URBAN SCIENCE:

III. PHYSICAL AND BIOLOGICAL SCIENCES

by: Anthony G. White

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Most of the problems in both the physical and social sciences involve either predictive or explanative processes. Two of the most frequently-asked, and most basic, questions are: Why did that happen? and What would happen if I do this?

These questions lead the researcher to take an orderly look at the available data and generate testable hypotheses. These hypotheses, concerning some problem or process, are then tested in carefully limited environments, and the results are compared with the hypotheses' predictions to check for congruence. This is the framework of science, a relatively hit-and-miss procedure which usually turns up a lot of experimental failures.

If urban science is ever to generate a coherent body of data within its interdisciplinary boundaries, one of two things is going to have to happen. First, the people in urban areas are going to have to overcome the natural human reluctance about being part of an experiment - a highly unlikely outcome; or second, the urban scientist is going to have to become a mathematician.

Given the premise that urban science - the interwoven skein of sociology, political science, physical science, economics, and so forth as relates specifically to urban areas - will someday be recognized as an organized body of data, theory, and practice, then the practicioner of the same is going to have to learn mathematics. For if people and institutions are unwilling to participate directly in knowledge-gathering processes, then they will have to be represented mathematically in models, simulations of the actions of real life.

This bibliography is the third in a series of four dealing with mathematics in some of the disciplines of urban science. The four areas of concern, and their subcate-

gories, are as follows:

I. Political Science and Economics

Empiricism	Regional economics
Behaviorism	Microeconomics
Government structures	Public finance
Public administration	

II. Sociology

Locational analysis	Criminology
Urbanization processes	Migration
Demography	Social psychology
Small groups	Occupational sociology
Aging	

III. Physical and Biological Sciences

Geography	Network theory
Cartography	Ecology
Meteorology	Public health
Hydrology	Mental health
Physics	Adaptive processes
Chemistry	

IV. Technology and Planning

Computers	Regional planning
Simulation	Land use planning
Games and game theory	Policy analysis

In addition to each bibliographical source, a numerical indicator following each entry gives the general level of mathematics used, according to the following key:

0 - Deductive and Inductive Logic; Set Theory; Numbers; Simple Graphs and Charts; Tables; Percentages

1 - Algebra; Geometry; Trigonometry; Functions; Equations; Systems

2 - Probability; Combinations; Permutations; Statistics; Index construction

3 - Vectors; Matrices; Linear Algebra

4 - Networks; Information Theory; Communications Theory; Graph Theory

5 - Computers and Programming; Simulation; Game Theory

6 - Integral and Differential Calculus

7 - Ordinary and Partial Differential Equations

8 - Complex Analysis; Calculus of Variations; Difference Equations and Calculus

9 - Higher order mathematics (e.g., abstract algebra, topology, differential geometry, etc.)

Each succeedingly higher-numbered entry presupposes a knowledge of the material in the lower-numbered entries.

Of necessity, each of these bibliographies will be relatively short. Only in the last twenty years have mathematics played an important role in social science thinking, relative to urban studies. Sources that depend solely upon standard statistical analyses have been avoided, in large part because of the misuse of statistical techniques both in and out of social science studies. Focal in these collections are works in which mathematics play a developmental role, starting with basics and working through advanced concepts, which yield testable, quantifiable systems of analysis for predictive and explanatory purposes.

Conspicuously absent from these listings are the more general mathematical works - national and macro-economics, national and world demography, and so on. These are avoided for the reason that the same potential relationship might exist between the urban level and higher levels as exists between Newton's "Laws of Motion" and Einstein's Theory of Relativity - what may hold as workable on the local level may not apply generally, and vice versa.

As a preliminary matter, a series of mathematical texts is first listed which should give the reader sufficient review of the necessary mathematics up to the level of difficulty desired. (Note: The author received his B.S. in Mathematics from Oregon State in 1967, and was a teaching assistant in the Mathematics Department of the University of Delaware in 1968.)

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MATHEMATICS IN URBAN SCIENCE:

IV. TECHNOLOGY AND PLANNING

by: Anthony G. White

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Planning and technology play an increasingly important role in the operation of local and urban governments. Both areas are interrelated, and to a certain measure dependent upon one another.

Planning requires both a knowledge of goals and an estimate of future resources and requirements in order to effectively prepare for the probable eventualities of housing, recreation, transit, land use, and other such needs.

Technological developments, such as computer hard- and soft-ware and systems-analysis techniques, aid in the control of traffic, cost accounting for purchasing and supply maintenance, payroll, and personnel systems.

Mathematics are needed in both areas to master the skills involved. It enables the planner to analyze past and present trends to project for future requirements, and it enables the technician to operate his systems and apply such systems to the needs of the city and of the planner. Both are thus tightly bound to the fabric of urban science and the tool of mathematics.

Given the premise that urban science - the interwoven skein of sociology, political science, physical science, economics, and so forth as relates specifically to urban areas - will someday be recognized as an organized body of data, theory, and practice, then the practioner of the same is going to have to learn mathematics. For if people and institutions are unwilling to participate directly in knowledge-gathering processes, then they will have to be represented mathematically in models, simulations of the actions of real life.

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